Shape Characterization on Turtle Detection

By SUNARDI

SHAPE CHARACTERIZATION ON TURTLE DETECTION

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Abstract

All sea turtles are considered as endangered and threatened that is affected by some natural and other caused by human activities. One of the problems faced on fishing operation is caught on gill net. Turtle Excluder Device (TED) is developed to prevent turtle approaches the net by dispels the sound signal. The objectives of this research project is to develop a system for identify the presence of turtle by using shape characterization. Turtle identification deployed by using underwater video camera with implementation of MATLAB software. The Green turtle (Chelonia Mydas) for various ages are used. The parameters are the head, tail, flippers and carapace of orientation. The characterization of parameters identified based on the analysis on image processing. The shape parameters of flippers are shown as the most identified. The orientation front and side easily to recognize the turtle present. In addition, for detection of turtle should over than 5000 number of pixels is identified as a turtle. This information will used to identify the turtle and prevent caught in the fishing net using improvement of TED with sound signal and image detection. Therefore, the endangered turtle can be protected and fisherman also can improve their efficiency and help to safeguard marine ecosystems.

Keywords: *Image Processing, Shape, Turtle, TED, Underwater*

INTRODUCTION

Conservation of sea turtles are affected by a range different factor, natural and others caused by human activities, including fishing operation. There are seven species of sea turtle in official Red List of International Union for conservation of Nature (ICUN 2004) classified at endangered species or critically endangered species [1]. The most critically endangered sea turtle species were Green Turtle, Hawksbill, Loggerhead and Olive Ridley.

Fisheries activities have been contributed to be a major factor of death for juvenile and mature sea turtles. During their long lifetimes, they are swimming hundred thousands of ocean miles and exposed of many threats. They are unintended catch of non-target species in shrimp trawl nets and fishing gillnets. Although there are method to avoiding turtle from trapping in fisheries net such as gear modification, material, fishing method, and prohibits for fishing activities using gill net, but these methods seems not affectively way to avoid the turtle trapping in fisheries net.[2]

There are many research of fishing equipped by using Turtle Excluder Device (TED) to reduce the number of turtle catch and dispels the turtle using sound signal [3]. Method of target strength using Echo sounder has certain cases of similar signal sound between fish and juvenile turtle [4]. There were certain cases of overlapping signal between fish and juvenile turtles. From the research, the started overlapping values of target strength signal between fish and juvenile turtle about -37.103dB due to the small size of juvenile turtle. Therefore, underwater video camera will be used to detect the presence of turtle based on its shape is the second method to protect the sea turtle from get caught it approaches the net [2].

By using underwater video camera, the sea turtle can be determined from the external characters. Shape detection of turtle or fish will be make analysis more accurate of image processing method [5]. By this system, the endangered turtle can be protected and fisherman also can improve their efficiency and help to safeguard marine ecosystem for minimal manual inspection.

TURTLE IDENTIFICATION

In the 1970's a fisherman named Sinkey Boone was the first person developed the Turtle Excluder Device (TED). But in 1980's United States required all their trawling shrimping boat use and put TED to their net. TED was created to save the fuel costs, help save on net repair, can improve the quality of catch and can release turtle. Unfortunately, there are problems uses this TED which all their catches are decreasing. This is because in TED have a trap door use for turtles and other huge animal to release the fish net but the same time all fish also follow and it makes the fisherman reducing their catches [5][6].

Turtle is classified at endangered species or critically endangered, therefore need to conservation [1]. These marine reptiles are characterized by a large, streamlined shell (carapace), and non-retractable head and flippers. In all species except the leatherback, the body is covered with hard, keratinized plates called "scutes". The number and arrangement of scutes on the carapace and head are used to identify between the species. Sea turtles range in color from pale green to almost black. Jaw shape also varies among species, adapted to its diet. There is no sexual dimorphism (physical differences between males and females) with the only difference in adult turtles being the size of tail. Adult males have a much wider and longer tail than females [7]. Thus, different of turtle will be different key of identification and characterization of species.

Green turtle (*Chelonia Mydas*) can be distinguished from one another by the scale on top of the snout, called the prefrontal and by the scutes on the carapace. The green turtle has one pair of prefrontal scales). The carapace is smooth with 4 pairs of lateral scutes. Carapace colour changes with age. It is black in hatchlings, then turns brown and tan in juveniles, and in adults, it is olive or gray-green, sometimes with speckles of yellow and brown. The plastron is white in hatchlings. It turns creamy yellow, sometimes temporarily pink or grey depending on the population [8]. With their characterization identification, the sea turtle can easily distinguished and differentiate with the fish because their share the same habitat in the sea. The characteristic of Green turtle is shown in Figure 1.

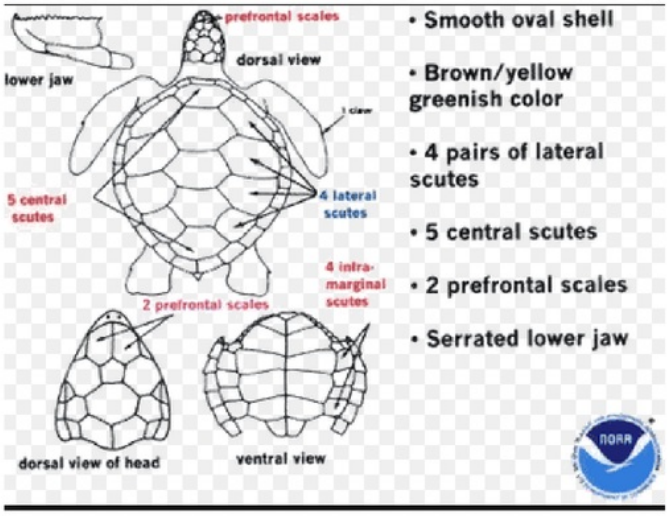

Figure 1. The characteristic of Green Sea Turtle [9]

Underwater Video Camera

Underwater video camera is one of device that uses to detect the marine species such as turtle and depth of the water. Video equipment and underwater observatories enable to be obtained in mid water seafloor and habitats, providing high-resolution data at the scale of the individual

ganisms and their natural aggregation pattern. Now days, the research for automated the measurement and counting task in order to improve the efficiency of the process and expand the use of underwater video camera within marine science. The automated process will require the detection and identification of target for measurement followed by counting and tracking [10]. This tools are useful to observe such sea turtle behavior but difficult to obtain clear and bright visual.

However, the data of video and image is needed to be analysis to identify the shape of the image. Therefore, to make the task of identifying the image easier, image pre-processing techniques can be performed. Through the use of specific image enhancement techniques, the image may be taken to the stage where computer can start to identify objects within that image. The ultimate goal of such a system is autonomously detect an object, identifying it and classify it within a database of known object in real time [10] [11]. To get the real and specific image of object detected, the analysis segmentation is most important at real-time.

Image processing is needed to be applied through certain types of filters to preserve the image information but at the same time improving the image by removing the noise. Image processing generally targets on better identification of object of interest, which can distinguish from other objects or region, and background [12]. There were many methods in image processing that can be used in any types of images. Identification can be made only for single turtle for cheaper purposes by feature extraction using MATLAB software. The feature extraction mainly comprises of length, breadth, shape and color to identify the particular species of the sea turtles. Color extraction is applied to extract specific color of the image by the image pixels as 0 to 255. The range threshold value of image RGB reaches the threshold value it is considered as turtle otherwise images will be rejected. Morphological operation had been used to remove small patches and smoothing the image of turtle. The morphological operation is more effective while compared with filtering technique since it will reject the certain types of noise were the individual pixel is cleared from images and will be more effective. The method chosen to detect the presence and the characterization of turtle is threshold values with morphological operation. The concept of this method is simple and can be apply by user easier.

METHODOLOGY

The main idea of this research is to detect the presence of turtle based on shape characterization and parameters of orientation with implemented of MATLAB software. The automatic detection using of image processing is proposed to detect the characteristics of Green turtle. In processing stage, the color recognition using threshold in HSV method to detect the type of parameters of turtles within different of orientation. The process is continued with feature extraction and classification stage. The image of turtle is obtained based the parameters of head, tail, side and carapace of orientation. This research was deployed in a sea water pool of 7meter length, 2meter width, and 1 meter depth.

The equipment used was underwater video camera as a cheaper technology and affordable for people. The underwater video camera will capture images and record videos. Model of Gopro Hero 3+ was chosen as the equipment of this research. The resolution of video 848X480 pixel with 60 frames per second will shoot the sharp images and high speed recording. The maximum depth of this equipment is up to 197 ft. In addition, it also provided wireless connection (LAN) and can controlled via Android and IPhone devices.

The equipment of underwater video camera was located static at the end of pool and it was controlled via Android system. In addition, the placed of equipment was changed if the turtle suddenly become aggressive. The freely movement of turtle created the different parameter obtained from different of orientation. The image of turtle was also taken by the burst images which are 15 images per once press of button capture mode. Total of sample video recorded were 20 video and will be extracted frame by frame. Then, the presence and the parameters will be obtained by the image processing method.

Video of turtle is recorded within 1 minute. Then, the video will be extracted frame by frame and all images are resized 480x270 pixels. Each of frames will be analyzed by image processing

stages which were threshold in HSV and morphological operation. Next, the decision presence of the turtle is based on the number of pixel image. The number of pixel more than 5000 pixels identified as a turtle instead of fish or other object. The block diagram of this research shown in Figure 2.

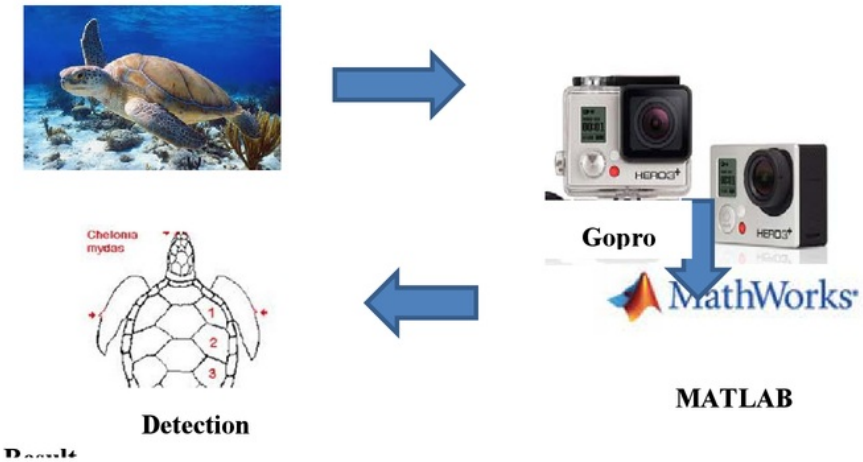

Figure 2. Block diagram of research

Data Acquisition

The turtles from juvenile until mature at ages 2, 5, and 12 years are used as listed in Table 1. All the turtles are same species of Green turtle. The video is recorded the movement of turtle within 1 minute from different orientation.

Table 1. Characteristic of turtles

Turtles	Age (years)	Weight (kg)	Shell Length (cm)
1	2	2.5	29 x 28
2	5	10	43 x 41
3	12	25	58.5 x 51

The video will be extracted frame by frame by using MATLAB code. All the type of video file format can be extracted and saved as PNG format. When the video is executed, the command prompt will be displayed the output of extracting and saving frame of video file. When the video is executed, the command prompt will be displayed the output of extracting and saving frame of video file.

Processing Stage

Hue, Saturation, Value (HSV) is a color model that describes colors in terms of their shade and their brightness as the color features extraction. This method is used to convert the RGB color to HSV color space. The 30 samples of turtle were used to obtain the ranges of HSV based on the parameters of head, tail, flippers and carapace and the ranges value of HSV was between 0 until 1. There are 3 values of Hue color which were brown, gray and yellow. The fraction between 0 and 1

were described the Hue by specified the position of the corresponding pure color on the color wheel.

The grey in color space was indicated by the saturation of range 0 to 1. The value of 0 was the color grey and when more the color grey, the saturation level is lower and will become faded color. The saturation value of 1 is a primary color. The brightness of color space is depending on the ranges value of luminance or value and the ranges is 0 to 1. The 0 values is describes the color space is totally black and increasing the value toward 1 shows the color brightness up. Then HSV in pixels ranges was pointed and the mask is applied during filtered the image. In a binary image, while the HSV range value of image was satisfied and show black and white color image. All the pixels that appointed by the HSV range are marked as foreground which are in white color and otherwise showed in black as the background marked.

Erotion and Dilation

From the HSV color method, the binary regions were distorted by noise and texture due contain numerous imperfections. Morphological image processing pursues the goals of removing these imperfections by accounting for the form and structure of the image [10]. For minimize the output pixel, the structuring element of disk was choose to remove the small shape at all location with corresponding neighborhood of pixels.

Se=strel('disk',1);

Erode=imerode(fill,se);

The morphological opening with disc structuring element will smooth the corner from the inside and closing with discs smooth corner from the outside. The portion of '1' is blocked and excluded the output image. It was thinning the desired image shape and act as filters of shape. The size of output image value is 'fill' was computed the full erosion to close the background.

Dilation function is to make the image become larger or smaller without change the shape of image. After erosion process, the image should be restored to their original sizes by the same structuring element.

Sel=strel('disk',1);

Dilate=imdilate(erode,sel);

All sides of image will be foreground by 1-by-1 disk structuring element. The basic effect of the operator on a binary image is to gradually enlarge the boundaries of regions of foreground pixels typically white pixels. In this project, the structuring element disk due rounded off the corners and boundaries become rounded. The shape of disk argument will be affected the output image.

RESULTS & DISCUSSION

The results were discussed one by one based on each processes done according to the method proposed. There are 10 samples of turtles were used for the analysis process and the characterization parameters of head, carapace, flippers and tail was determined. Besides, the effectiveness of this project was testing with different condition. The obtained results were compared and noted in order to improve the lacking part of the project developed.

Turtle is identified and recorded the video of movement turtle in the large pool for 1 minute per video. Then, the video is displayed and analyzed each of extracted frames to detect the presence of turtle. The frame was selected based on the status of each frame to study the characterization of turtle based on the parameters of head, carapace, flippers and tail orientation. However, the type of analysis of collecting data for the whole project is done in offline condition. The extracted of frame is originated in GIF file format and needs to be converted to JPEG or PNG file formats for the better vision of detecting regions. All images are resized to 480x270 in the MATLAB programming to ensure the process flow evenly throughout the simulations.

Analysis of Processing Stage

The main principle behind threshold in HSV is that image pixels, falling into a predefined range of intensity values, are assigned a single intensity value, and the remaining pixels are assigned a different intensity value. The threshold is depended each pixel on the image characteristics. For this project, the image characteristics is standardize and easily for performance.

Thresholding in HSV technique is suitable for allow only the setting shape remain in the picture while the shape out of wetting will be removed. The intensity value for the characteristic of turtle is different for head, flippers, carapace and tail. They are include 4 type of color for detection which are brown color for carapace, gray color for head, yellow for flippers and tail. The blue color of water as the background is removed but remains the shape of turtle found. The pixels of hue, saturation and luminance (value) for HSV are manually determined by using paint with color picker.

By using Thresholding in HSV, we can match the turtle by describing colors and allow independent control over hue, saturation and luminance (value). In HSV, the highest value among RGB numbers is divided by 240 to scale between 0 and 1 because the maximum value in paint configuration for the hue, saturation and value. The brighter colors have near 1 and become darker when color near to the 0.

Table 2. Threshold value for each parameter color in HSV

Color	Parameter	Hue(H)	Saturation (S)	Value(V)
Brown	Carapace	0.15-0.40	0.00-0.60	0.20-0.98
Gray	Head	0.15-0.45	0.00-1.00	0.00-1.00
Yellow	Flippers	0.50-0.98	0.02-0.30	0.00-0.90
Yellow	Tail	0.02-0.40	0.00-0.40	0.00-0.70

After 30 image selected, the standardize range is determined for hue, saturation and value. If the brown color patch is taken the hue value is 58, saturation value is 120 and value or luminance is 240. After divided by 240, hue value became 0.24, saturation value is 0.5 and value or luminance is 1. Table 2 shows the value of yellow patch is satisfied the threshold value and the yellow color can be detected. If there out of the range, the color cannot be detected.

The gray image is generated from threshold in HSV color image. The MATLAB function *rgb2gray* is used. The Grayscale image is converted to binary image which easier to detect the shape of parameters. Binary image typically black and white which are image binary BW has values of 1 (white) for all pixels in the input image and 0 (black) for all other pixels.

The erosion is deleted having a radius less than 4 pixels by opening it with the disk-shaped structuring element. Morphological operations run much faster when the structuring element uses approximation (N>0). However, structuring elements that do not use approximations, (N=0) are not suitable. The structuring image of 'disk' and value of 1 is used to eliminate the noise and smooth the corners of the image. Erosion removes small-scale details from a binary image but simultaneously reduces the size of regions of interest, too. By subtracting the eroded image from the original image, boundaries of each region can be found.

By using dilation the image should expand and larger for clearly detect the shape of parameters. *Bwboundaries* traced the exterior boundaries of objects as well as boundaries of holes inside in the binary image, *BW*. For the better performance, *Logical(bw)* assigned regions in the label matrix. The code read in and threshold an intensity of object. *Regionprops* to obtain estimates of the area all of the objects. The label matrix returned by *bwboundaries* can be reused by *regionprop*. The red rectangle of bounding box is created at the parameters detected but also

includes noise. At the end of the processing stage, the mean value, number of pixels and area in pixel is calculated using this formula.

Numberofpixels1=sum(erode(:));

Numberofpixels1=bwarea(bw);

Meanpixel=mean(gray(erode));

Classification and Testing Stage

Once the object boundaries have been recognized, the area can be calculated easily by summing the number of pixels within the boundary extent. Objects correspond to noisy pixels that may have been treated as object pixels during the thresholding process. It is necessary to remove these pixels before further processing by erosion. By using an if-else condition, those objects whose summation of erode are below a numbers of pixels value, can be converted to background pixels. For the testing stage, video analysis frame by frame and image selected for 3 different of orientation which are front, side and back detected are used to define the system detection the object and recognized the present of turtle and the characterization based on parameters.

Video is displayed as input and analyzed frame by frame. Each frame is analyzed the detection and the status of detection will indicate either 'Turtle Found' if the number of pixels id greater than 5000 pixel and less than 5000 pixel is for 'Turtle not Found'. Through the processing stage, the image of turtle can be obtained from each frame on video. The extraction of frame is saved in a folder. From the status of detection, the frame number will be recognized and the image selected to study the characterization of turtle based on the parameters.

The Turtle Identification System is tested by the picture of turtle and the detection status indicated the "Turtle Found" as shown in Figure 3. At the end of the process the mean value area is 150.656, Number of Pixels is 59550 pixels and area in pixels is 57169.3. The characterization of turtle based on parameters is checked. Each parameter is manually observed and ticked fulfilled as a turtle. If the characterization of parameters as a turtle not satisfy but the status indicates 'Turtle Found', it considered as noise and need to select other of frame to have accurate result. However, the noise also is there because the color of flipper is look same with the intensity light (noise) of water. The parameters can be detected, the Threshold in HSV of hue, saturation and luminance or value when they are satisfied in the standardize range of value.

Figure 4 shows the summary of processing stage that include the Thresholding in HSV, Grayscale Image, Binary Image, Erosion and the last is dilation process. The characterization of parameters can be obtained by the *BoundingBox* at the area detected. The characterizations identified are head, flippers and carapace.

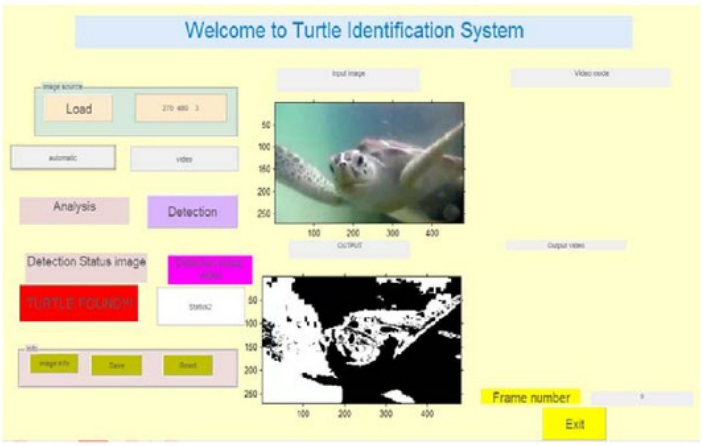

Figure 3. GUI for system detection

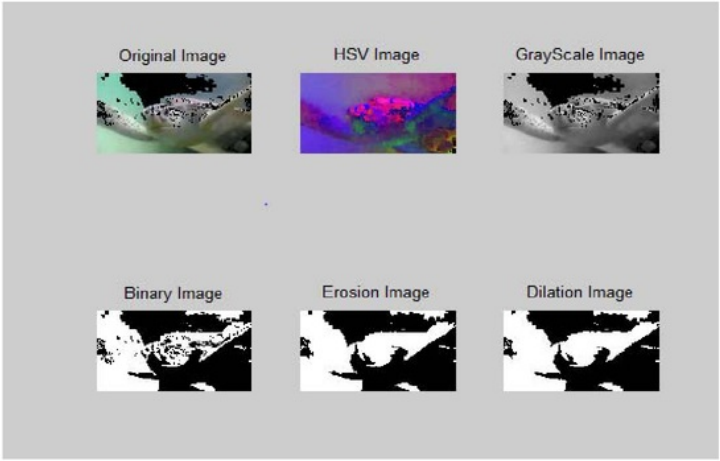

Figure 4. Front orientation

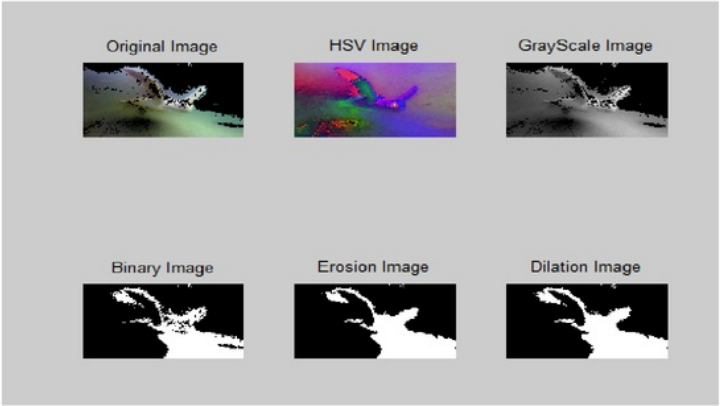

Figure 5. Side orientation

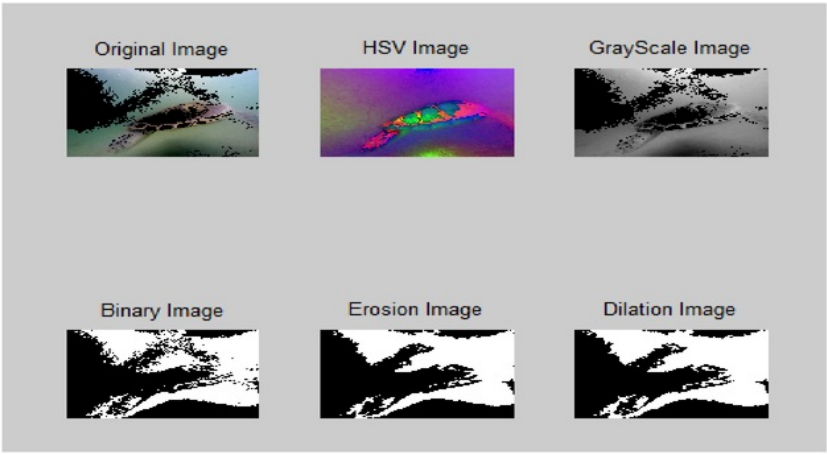

Figure 6. Back orientation

The 10 samples of turtle also tested. The parameters of head are the most identified. Parameters of carapace are half of samples can be recognized and flippers 7 samples. Different of orientation view, have different parameters obtained, such as side orientation in Figure 5, the parameters obtained are head, carapace and flippers. The status detection indicates 'Turtle Found' with the number of pixels is 6612. At the side orientation, the parameters of flippers are clearly recognized as a turtle and followed with carapace and head. For back orientation, the parameters identified are carapace and flippers as shown in Figure 6. The 10 samples of turtle at side and back were tested and the result of parameters identified

The parameters of carapace are the most identified at the back orientation. The parameters of flippers also can be obtained for the 8 samples but none identified of parameters for head and tail. All the samples of turtle orientation summarized as shown in Table 3. From all orientation, the total identified of parameters for head, carapace and flippers were 18, 19 and 22 respectively. The parameters of tail for all orientation are no identified.

Table 3. Summary of parameters identified of all orientation

Orientation	Head	Carapace	Tail	Flippers
Front	10	8	0	10
Side	9	10	0	10
Back	0	10	0	10
Total	19	28	0	30
Percentage (%)	63.3%	93.3%	0%	100%

The parameters of flippers are the most identified with 22 found and the percentage is 73% for all the orientation. While the total parameters found for head and carapace are 18 and 19 with the different 3% among them. Unfortunately, parameters of tail could not found for all the sample and orientation because their size is small and under the carapace. Usually, the size of tail can determine the gender of turtle either female or male. In this project, the gender of turtle cannot be determined and the shape of tail cannot be recognized. Overall of the samples, at the front orientation the head parameters are most recognized and the flippers for the side orientation.

For the analyzed without turtle the mean value area is 0.000, number of pixels is 1.0 and area in pixels is 192.88. The shape parameters cannot be detected, the Threshold in HSV of hue,

saturation and luminance or value is not satisfied in the standardize range of value. Therefore the detection status indicates "TURTLE NOT FOUND".

The mean value area is 144.482, number of pixels is 4719 and area in pixels is 6154.88. The shape parameters cannot be detected, the threshold in HSV of hue, saturation and luminance or value is not satisfied in the standardize range of value. However, we can detect the area of parameters according to the range value of HSV. But the parameter is not the turtle characteristic because it is a fish. Therefore the status indicates "TURTLE NOT FOUND".

In the overall processes, the 30 images tested showed positive result for detecting the turtle found and shape of turtle is recognized. However, the shape detected is different according to the size of turtle and the edge of captured the image. For additional needs, a case of none turtle and fish is also tested. Thresholding in HSV, the color between the turtle with the fish can be differentiated. The system indicated the status of the detection depend on the value of pixels. The decision of turtle detected when the number of pixels is greater than 5000 after analyzed of 30 images. It proven that the values of pixels without turtle and with the fish give different value pixels and less than the value of the decision. However, the number pixel obtained included with noise due to the milky water and shallow depth. The milky water causes the image hard to recognize after process. The characterization of parameters based on head, carapace, tail and flippers were manually recognized by compared the parameters obtained. If the one of parameters are satisfied identified, the image will be categorized as the turtle found.

CONCLUSION

Turtle is endangered species in the world, and most factors for decreasing the population is from the fishing activity. As we know, the turtle commonly trapped in gillnet of fisherman. Turtle Excluder Device (TED) is developed to reduce the number of turtle trapped in gillnet by dispels signal of sound for them. However, the overlapped signal between fish and turtle is cause of the detection not accurate. Improvement of this system, the detection by image processing is developed as the second method to detect the turtle. The color and the shape between the fish and turtle are different. As a starting point for the development of image processing analysis technique for detecting the present of turtle, 1920x1080 is produced pixels by underwater video camera but for the easier and fast analysis of image then was resize to 480x270 pixels. From the analysis of processing stage, the shape of turtle can be recognized based on the parameters of head, carapace, tail and flippers. The shape parameters after the processing stage is not properly look like the original image but the shape still recognized. It was cause by the intensity of light and condition of water as the noise. In addition, from the analysis between the turtle, the range number of pixels is obtained and makes it different with the fish. The range number of pixels for turtle is greater than for fish. In this rsearch, the GUI system is successfully developed to detect the present of turtle and analyzed the parameters of turtle.

The result also has an undetected the shape of turtle, this situation may occur due to the depth of water because the depth in the pool and the distance is small make the data obtained not from several of distance. For the future, the research can identify the shape of turtle from the several of distance. In addition, the real time for the detection using live streaming video and combination of signal of turtle is suggested for more improvement on turtle detection.

REFERENCES

1. Red List of International Union for Conservation of Nature (ICUN), 2004
2. Sunardi, Noor Zirwatul Ahlam, Azrul Mahfurdz, Anton Yudhana, 2013. Prevent Turtle Trap in the Fishing Gear Using Ultrasound, IEEE Conference on Industrial Electronics andApplications, Melbourne, 19-21 June 2013
3. The Humane Society of the United States, September 2005, Turtle Excluder Device (TED).

4. Azrul Mahfurdz, Sunardi, Hamzah Ahmad, 2013. Acoustic Strength of Green Turtle and Fish Based on FFT Analysis, International Journal of Advanced Computer Science and Applications(IJACSA), Volume 4 Issue 9, 2013
5. G. Schofield, 2008. Identification Tree: Group Assignation of the right facial scales
6. Food and Agriculture Organization Of The United Nations Rome, Guidelines To Reduces Sea Turtle Mortality, 2009.
7. Bastiaan J. Boom, Phoenix X. Huang, Cigdem Beyan, 2008. Long-term underwater camera surveillance for monitoring and analysis of fish populations.
8. National Marine Fisheries Service and the Atlantic States Marine Fisheries Commission, 2013. Workshop on Sea Turtle and Atlantic Sturgeon Bycatch Reduction in Gillnet Fisheries.
9. Jeanette Wyeken, December 2001. The Anatomy of Sea Turtles.
10. Chong Soon, Tan Phoo Yee Lau, Detect of marine species on under water video image, 2014.
11. R.N.Williams, A.F.Kelsall, T.J.Lambert, T.Pauly, 2006. Detecting Marine Animals in Underware Video.
12. Mark R.Shortis, Mehdi Ravanbakskh, Faisal Shafait, A review of techniques for identification and measurement of fish in underwater stereo-video image sequences, 2010.

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